(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 287 341 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification: **17.06.92** (51) Int. Cl.5: **A61K 31/195**, A61K 9/02

(21) Application number: **88303306.0**

(22) Date of filing: **13.04.88**

(54) Rectally absorbable form of L-dopa.

(30) Priority: **17.04.87 US 39406**

(43) Date of publication of application:
19.10.88 Bulletin 88/42

(45) Publication of the grant of the patent:
17.06.92 Bulletin 92/25

(84) Designated Contracting States:
CH DE FR GB IT LI NL

(56) References cited:
EP-A- 0 228 253
FR-A- 2 085 735

CHEMICAL ABSTRACTS, vol. 107, no. 23, 7th December 1987, page 13, no. 211457v, Columbus, Ohio, US; D.R. COOPER et al.: "L-Dopa esters as potential prodrugs: behavioral activity in experimental models of Parkinson's disease" & J. PHARM. PHARMACOL. 1987, 39(8), 627-35

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Description

The invention relates to compositions of ester prodrug derivatives of L-dopa for enhancing absorption via rectal therapeutic application. More specifically, the invention relates to substituted and unsubstituted mono-, di- and polyhydroxyalkyl esters of L-dopa and their pharmaceutically acceptable counterion salts. Also, the heretofore disclosed compositions and methods may optionally include a decarboxylase inhibitor such as carbidopa and benserazide. The inhibitor serves three vital roles, namely, 1.) prevents the breakdown of L-dopa, 2.) reduces commonly know side effects, and 3.) allows further expression of L-dopa pharmacological activity.

L-dopa is usually orally given with a L-amino acid decarboxylase inhibitor. Given in this fashion, L-dopa is effective in the treatment of Parkinson's disease. However, presumably due to erratic absorption and blood levels, control of disease symptoms is not always adequate. L-dopa esters have not provided significant advantages when given orally. This is probably due to ester hydrolysis in the g.i. tract and/or presystemic metabolism. These problems are ameliorated by the rectal route.

As employed in this application, the expression "prodrug" denotes a derivative of a known and proven prior art compound, which derivative, when absorbed into the bloodstream of a warm-blooded animal, "cleaves" in such a manner as to release the proven drug form and permits the same to afford improved therapeutic efficacy than that which could be obtained if the proven drug form, per se, was administered.

Also as employed in this application, the term "cleavage" denotes that the proven drug form is released and the remaining "cleaved" moiety is non-toxic and metabolized in such a manner that non-toxic, metabolic products are produced.

It is known to the art that dopa, L-dopa and dopamine, and their salts, are useful active agents for the treatment or management of a wide variety of disease states or conditions, e.g., they are useful anticholinergic agents, antiparkinsonian agents, adrenergic agents, cardiotonic agents, See generally Cutting's Handbook of Pharmacology, 41, "Sympathetic Stimulants of Adrenergic Agents", pp. 436-455, Sixth Edition (1979); The Merck Index, pp. 3424 & 5314, Ninth Edition (1976).

Nevertheless, it is also known to the art that sympathomimetic amines and various art-recognized therapeutically active derivatives thereof, are characterized by certain inherent disadvantages, notably serious bioavailability and physiological availability problems upon administration. Such reduced availability can be attributed in part to poor lipid solubility [by reason of the presence of the hydrophilic phenolic hydroxyl groups], and also to metabolic losses during and following conventional administration.

Also, it is further known to the art that L-dopa, following oral administration, undergoes extensive metabolism within the stomach and small intestine. Esters of L-dopa, when given orally, offer no advantage over L-dopa itself. Additionally, certain portions of the patient population experience extreme difficulty in swallowing oral formulations.

The invention relates to compositions and methods of enhancing rectal absorption of ester prodrug derivatives of L-dopa, specifically, the substituted and unsubstituted mono, di-and polyhydroxyalkyl esters thereof and their pharmaceutically acceptable counterion salts. Optionally, said compositions may include a decarboxylase inhibitor such as carbidopa and benserazide. Thus, there exists a need for an absorbable form of L-dopa which can be administered by an alternative route (other than oral), and which results in therapeutically effective plasma levels of L-dopa.

Accordingly, a major object of the invention is to provide an absorbable form of L-dopa for rectal application.

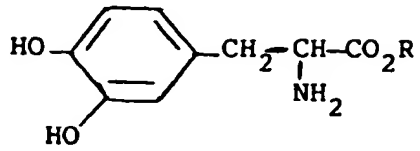
Another object of the invention is to provide a prodrug form of L-dopa which is characterized by enhanced solubility, can be administered in standard pharmaceutical formulations to warm-blooded animals to elicit a systemic physiological or pharmacological beneficial effect, and which exhibits enhanced bioavailability and physiological availability.

Still another object is to provide L-dopa prodrugs which will elicit a more effective sympathomimetic response, at lower concentrations or dosage levels, than its parent molecules.

The L-dopa esters of the invention can be administered rectally (with or without a decarboxylase inhibitor) as a suppository device. Release and absorption of the drug and subsequent hydrolysis in the blood would yield L-dopa which would be available to exhibit its intrinsic pharmacologic effects.

The invention relates to compositions for enhancing the rate of absorption of a rectally administered prodrug form of L-dopa. The compositions comprise an effective amount of an ester form of L-dopa (prodrug) and optionally a decarboxylase inhibitor such as carbidopa and benserazide formulated with commonly employed pharmaceutically acceptable excipients. The method generally comprises administering a dosage form capable of being rectally administered, wherein said dosage form comprises a therapeutically effective amount of an L-dopa ester in a sufficient quantity to be effective in enhancing rectal

absorption rates and optionally a decarboxylase inhibitor. The L-dopa prodrug ester derivatives of the invention are best described by the general formula below:



wherein R is substituted or unsubstituted mono, di or polyhydroxyalkyl(C_1-C_{20}) such as 4-hydroxybutyl, 2-hydroxybutyl 2-hydroxypropyl, 2,3-dihydroxypropyl, 1,3-dihydroxypropyl, 6-hydroxyhexyl and 5-hydroxypentyl optionally having a substituent such as alkoxy(C_{1-5}) [methoxy, ethoxy, and butoxy]; carbalkoxy (C_{1-5}) [methoxycarbonyl, ethoxycarbonyl, propoxycarbonyl and butoxycarbonyl]; amino; mono or dialkylamino(C_1-C_{10}) [methylamino, methylethylamino and diethylamino]; acylamino(C_1-C_5) [acetamido and butyramido] ; ketoalkyl (C_1-C_5) [methylketo, ethylketo and butylketo]; halo [chloro and bromo] or carboxamide; substituted and unsubstituted aralkyl(C_7-C_{20}) such as benzyl, alkoxybenzyl (C_8-C_{14}) [methoxy, ethoxy and isobutoxy]; phenylethyl; phenylpropyl; phenylbutyl; phenylhexyl; and phenyloctyl; and pharmaceutically acceptable organic or inorganic counterion salts.

The synthetic processes for preparing the esters of L-dopa and the salts thereof are known in the art, namely, U.S. Patent Nos. 3,891,696 and 4,035,507 and Journal of Pharmaceutical Sciences, 62, p. 510 (1973). For rectal application, the formulations may be prepared as microenemas, suppositories, rectal tablets, rectal devices, sustained-release formulations, and other standard procedures known in the art. The preferred formulation is a solid suppository comprising a pharmacologically required dose of the prodrug that is sufficient to provide therapeutic plasma levels of L-dopa, optionally a sufficient quantity of a decarboxylase inhibitor, and sufficient suppository base to formulate an acceptable composition. The methods and choice of excipients and suppository bases are well known to those skilled in the art and the composition of said formulations is not limited to solid suppositories by this invention.

Generally, the amount of active agent employed in the practice of the invention ranges from 200 mg to 2.5 grams per day. Optionally, a decarboxylase inhibitor may be included at 1:25 to 1:4 ratio of the amount of active agent. The percentage of pharmaceutically acceptable excipients employed herein can range from 55% to 95% of the total composition weight.

The following examples illustrate preparation of various compositions of the invention. The examples should be construed as illustrative rather than limitations thereof.

EXAMPLE 1

L-dopa bioavailability in rats following rectal administration of L-dopa 2-hydroxypropyl ester HCl

Each rat received 250 µl aqueous microenema (0.1% ascorbic acid, pH 5) containing either 2.0 mg L-dopa or 2.8 mg L-dopa 2-hydroxypropyl ester HCl in the presence or absence of 0.5 mg carbidopa. The solutions were administered at an intrarectal depth of 2.5 cm. Blood samples were collected for 90 minutes, plasma L-dopa determined, and percent L-dopa bioavailability calculated relative to intravenous L-dopa administration. The results are shown in the following table:

Administered Solution	Percent L-dopa bioavailability (mean ± SD, n=3)	
	No Carbidopa	With Carbidopa
L-dopa	3 ± 2	9 ± 6
L-dopa hydroxypropyl ester HCl	8 ± 3[a]	19 ± 9[a]

[a] Statistically greater than L-dopa administration at the $p < 0.05$ level

EXAMPLE 2

L-dopa bioavailability in rats following rectal administration of L-dopa 4-hydroxybutyl ester HCl

Each rat received a 250 µl aqueous microenema (0.1% ascorbic acid, pH 5) containing either 2.0 mg L-dopa or 3.1 mg L-dopa 4-hydroxybutyl ester HCl in the presence or absence of 0.5 mg carbidopa. The solutions were administered at an intrarectal depth of 2.5 cm. Blood samples were collected for 90 minutes, plasma L-dopa determined, and percent L-dopa bioavailability calculated relative to intravenous L-dopa administration. The results are shown in the following table:

Administered Solution	Percent L-dopa bioavailability (mean ± SD, n=3)	
	No Carbidopa	With Carbidopa
L-dopa	3 ± 2	9 ± 6
L-dopa 4-hydroxybutyl ester HCl	100 ± 13[a]	100 ± 45[a]

[a] Statistically greater than L-dopa administration at the $p < 0.05$ level

EXAMPLE 3

L-dopa bioavailability in dogs following rectal administration of L-dopa 4-hydroxybutyl ester HCl

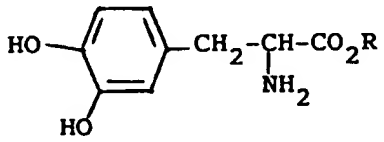
Dogs were pretreated for 3 days with oral carbidopa (25 mg b.i.d.). Each dog, on the study day, received a 1 ml aqueous microenema (0.1% ascorbic acid, pH 5) containing either 50 mg L-dopa or 77.5 mg L-dopa 4-hydroxybutyl ester HCl. The solution was administered at an intrarectal depth of 4.5 cm. Blood samples were collected for 4 hours, plasma L-dopa determined, and percent L-dopa bioavailability calculated relative to intravenous L-dopa administration. The results are shown in the following table:

Solution Administered	Percent L-dopa bioavailability (mean ± SD, n=3)
L-dopa	<1
L-dopa 4-hydroxybutyl ester HCl	33 ± 14[a]

[a] Statistically greater than L-dopa administration at the $p < 0.001$ level

Claims

1. A pharmaceutical composition for enhancing rectal absorbtion of L-dopa comprising a therapeutically effective dosage amount of an ester of L-dopa of the structure formula:



wherein R is substituted or unsubstituted mono, di or polyhydroxyalkyl(C_1-C_{20}); and pharmaceutically acceptable organic or inorganic counterion salts.

2. The composition of Claim 1, wherein R is substituted or unsubstituted mono, di or polyhydroxyalkyl(C_1-C_{20}), selected from 4-hydroxybutyl, 6-hydroxyhexyl, 2-hydroxybutyl, 2-hydroxypropyl, 5-hydroxypentyl,1,3-dihydroxypropyl and 2,3-dihydroxypropyl.

3. The composition of Claim 2, wherein said substituted or unsubstituted mono, di or polyhydroxyalkyl is 4-hydroxybutyl, 2-hydroxybutyl or 2,3-dihydroxypropyl.

4. The composition of Claim 1, wherein said substituted substituents on the hydroxyalkyl group are selected from alkoxy(C_1-C_5), carbalkoxy(C_1-C_5), amino, mono or dialkylamino(C_1-C_{10}), acylamino(C_1-C_5), ketoalkyl(C_1-C_5), halo and carboxamide.

5. The composition of Claim 4, wherein said alkoxy is selected from methoxy, ethoxy and butoxy; said carbalkoxy is selected from methoxycarbonyl and ethoxycarbonyl; said mono and dialkyl-amino is selected from methylamino, methylethylamino and diethylamino; said acylamino is selected from acetamido, propionamido and butyramido; said ketoalkyl is selected from methylketo, ethylketo and butylketo; and said halo is selected from chloro and bromo.

6. The composition of Claim 4, wherein said alkoxy is methoxy, said carbalkoxy is ethoxycarbonyl, said mono or dialkylamino is methylamino or diethylamino, said acylamino is acetamido, said ketoalkyl is methylketo and said halo is chloro.

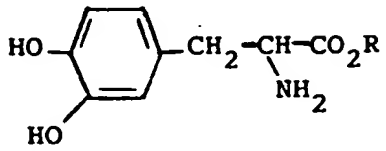
7. The composition of any one of claims 1 to 6, further comprising a decarboxylase inhibitor.

8. The composition of Claim 7, wherein said decarboxylase inhibitor is selected from the group consisting of carbidopa and and benserazide.

9. The composition of Claim 8, wherein said decarboxylase inhibitor is carbidopa.

10. The composition of Claim 1, in microenema or suppository form.

11. The use of an ester of L-dopa having the structural formula:



wherein R is substituted or unsubstituted mono, di or polyhydroxyalkyl(C_1-C_{20}); and pharmaceutically acceptable organic or inorganic counterion salts, thereof, for the preparation of a composition useful for rectal administration.

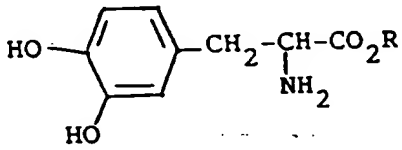
12. The use as claimed in Claim 11, wherein said composition further comprises a decarboxylase inhibitor.

13. The use as claimed in Claim 12, wherein said decarboxylase inhibitor is selected from carbidopa and benserazide.

14. The use as claimed in Claim 11, wherein said ester of L-dopa is in microenema or suppository form.

Revendications

1. Composition pharmaceutique pour améliorer l'absorption rectale du L-dopa, comprenant une quantité posologique thérapeutiquement efficace d'un ester de L-dopa de formule développée :



dans laquelle R est un groupe mono-, di- ou poly-hydroxyalkyle (en C_1-C_{20}), substitué ou non substitué; et les sels avec des contre-ions organiques ou minéraux pharmaceutiquement acceptables.

2. Composition selon la revendication 1, dans laquelle R est un groupe mono-, di- ou polyhydroxyalkyle (en C_1-C_{20}),substitué ou non substitué, choisi parmi les groupes 4-hydroxybutyle, 6-hydroxyhexyle, 2-hydroxybutyle, 2-hydroxypropyle, 5-hydroxypentyle, 1,3-dihydroxypropyle et 2,3-dihydroxypropyle.

3. Composition selon la revendication 2, dans laquelle ledit groupe mono-, di- ou polyhydroxyalkyle substitué ou non substitué est un groupe 4-hydroxybutyle, 2-hydroxybutyle ou 2,3-dihydroxypropyle.

4. Composition selon la revendication 1, dans laquelle lesdits substituants substitués sur le groupe hydroxyalkyle sont choisis parmi les groupes alcoxy (en C_1-C_5), carbalcoxy (en C_1-C_5), amino, mono ou dialkylamino (en C_1-C_{10}) , acylamino (en C_1-C_5), cétoalkyle (en C_1-C_5), halogéno et carboxamide.

5. Composition selon la revendication 4, dans laquelle ledit groupe alcoxy est choisi parmi les groupes méthoxy, éthoxy et butoxy; ledit groupe carbalcoxy est choisi parmi les groupes méthoxycarbonyle et éthoxycarbonyle; ledit groupe mono- et dialkylamino est choisi parmi les groupes méthylamino, méthyléthylamino et diéthylamino; ledit groupe acylamino est choisi parmi les groupes acétamido, propionamido et butyramido; ledit groupe cétoalkyle est choisi parmi les groupes méthylcéto, éthylcéto et butylcéto; et ledit groupe halogéno est choisi parmi les groupes chloro et bromo.

6. Composition selon la revendication 4, dans laquelle ledit groupe alcoxy est un groupe méthoxy, ledit

groupe carbalcoxy est un groupe éthoxycarbonyle, ledit groupe mono ou dialkylamino est un groupe méthylamino ou diéthylamino, ledit groupe acylamino est un groupe acétamido, ledit groupe cétoalkyle est un groupe méthylcéto et ledit groupe halogéno est un groupe chloro.

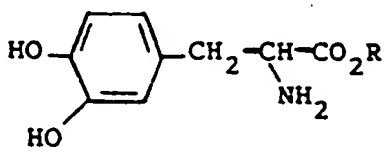
7. Composition selon l'une quelconque des revendications 1 à 6, comprenant, en outre, un inhibiteur de décarboxylase.

8. Composition selon la revendication 7, dans laquelle ledit inhibiteur de décarboxylase est choisi dans le groupe constitué par le carbidopa et le bensérazide.

9. Composition selon la revendication 8, dans laquelle ledit inhibiteur de décarboxylase est le carbidopa.

10. Composition selon la revendication 1, sous forme de micro-lavement ou de suppositoire.

11. Utilisation d'un ester de L-dopa de formule développée :



dans laquelle R est un groupe mono-, di- ou poly-hydroxyalkyle (en C_1-C_{20}), substitué ou non substitué; et de ses sels avec des contre-ions organiques ou minéraux pharmaceutiquement acceptables, pour la préparation d'une composition utile pour l'administration rectale.

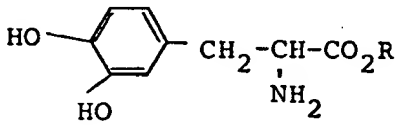
12. Utilisation selon la revendication 11, dans laquelle ladite composition comprend, en outre, un inhibiteur de décarboxylase.

13. Utilisation selon la revendication 12, dans laquelle ledit inhibiteur de décarboxylase est choisi parmi le carbidopa et le bensérazide.

14. Utilisation selon la revendication 11, dans laquelle ledit ester de L-dopa se présente sous forme de micro-lavement ou de suppositoire.

Patentansprüche

1. Pharmazeutische Zusammensetzung zur Verbesserung der rektalen Absorption von L-Dopa, welche eine therapeutisch wirksame Dosismenge eines Esters von L-Dopa der Strukturformel umfaßt:



worin R substituiertes oder unsubstituiertes Mono-, Di- oder Polyhydroxyalkyl(C_1-C_{20}) ist, sowie pharmazeutisch annehmbare organische oder anorganische Gegenion-Salze.

2. Zusammensetzung nach Anspruch 1, worin R substituiertes oder unsubstituiertes Mono-, Di- oder Polyhydroxyalkyl(C_1-C_{20}) ist, ausgewählt aus 4-Hydroxybutyl, 6-Hydroxyhexyl, 2-Hydroxybutyl, 2-Hydroxypropyl, 5-Hydroxypentyl, 1,3-Dihydroxypropyl und 2,3-Dihydroxypropyl.

3. Zusammensetzung nach Anspruch 2, worin das substituierte oder unsubstituierte Mono-, Di- oder Polyhydroxyalkyl 4-Hydroxybutyl, 2-Hydroxybutyl oder 2,3-Dihydroxypropyl ist.

4. Zusammensetzung nach Anspruch 1, worin die Substituenten der substituierten Hydroxyalkylgruppe ausgewählt sind aus Alkoxy(C_1-C_5), Carbalkoxy(C_1-C_5), Amino, Mono- oder Dialkylamino(C_1-C_{10}), Acylamino(C_1-C_5), Ketoalkyl(C_1-C_5), Halogen und Carboxamid.

5. Zusammensetzung nach Anspruch 4, worin das Alkoxy aus Methoxy, Ethoxy und Butoxy ausgewählt ist; das Carbalkoxy aus Methoxycarbonyl und Ethoxycarbonyl ausgewählt ist; das Mono- und Dialkylamino aus Methylamino, Methylethylamino und Diethylamino ausgewählt ist; das Acylamino aus Acetamido, Propionamido und Butyramido ausgewählt ist; das Ketoalkyl aus Methylketo, Ethylketo und Butylketo ausgewählt ist; und das Halogen aus Chlor und Brom ausgewählt ist.

6. Zusammensetzung nach Anspruch 4, worin das Alkoxy Methoxy ist, das Carbalkoxy Ethoxycarbonyl ist, das Mono- oder Dialkylamino Methylamino oder Diethylamino ist, das Acylamino Acetamido ist, das Ketoalkyl Methylketo ist und das Halogen Chlor ist.

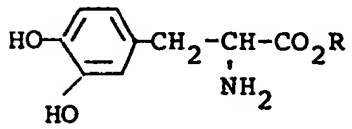
7. Zusammensetzung nach einem der Ansprüche 1 bis 6, welche weiterhin einen Decarboxylaseinhibitor umfaßt.

8. Zusammensetzung nach Anspruch 7, worin der Decarboxylaseinhibitor aus der aus Carbidopa und Benserazid bestehenden Gruppe ausgewählt ist.

9. Zusammensetzung nach Anspruch 8, worin der Decarboxylaseinhibitor Carbidopa ist.

10. Zusammensetzung nach Anspruch 1 in Form eines Klistiers oder Suppositoriums.

11. Verwendung eines Esters von L-Dopa mit der Strukturformel:



worin R substituiertes oder unsubstituiertes Mono-, Di- oder Polyhydroxyalkyl(C_1-C_{20}) ist, sowie pharmazeutisch annehmbare organische oder anorganische Gegenion-Salze davon, zur Herstellung einer zur rektalen Verabreichung geeigneten Zusammensetzung.

12. Verwendung nach Anspruch 11, worin die Zusammensetzung weiterhin einen Decarboxylaseinhibitor umfaßt.

13. Verwendung nach Anspruch 12, worin der Decarboxylaseinhibitor aus Carbidopa und Benserazid ausgewählt ist.

14. Verwendung nach Anspruch 11, worin der Ester von L-Dopa in Form eines Klistiers oder Suppositoriums vorliegt.